

Use of Supercharged Jejunal Flap for Esophageal Reconstruction

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Tubularized stomach is the preferred choice for esophageal reconstruction following esophagectomy. However, the thoracic surgeon is occasionally faced with situations where the stomach is either unsuitable or unavailable for use. In patients who have had previous gastric resection, the stomach will be of insufficient length to reach into the neck; indeed, the stomach may not be present at all. A prior omentectomy or omental flap results in the right gastroepiploic artery being unavailable on which to base a stomach conduit on. Gastroesophageal junction cancers may extend into the proximal stomach, and similarly, gastric cancers may extend into the distal esophagus, often necessitating total gastrectomy and esophagectomy. In patients who have undergone gastric irradiation, microvascular injury may impair the ability to perform a gastroesophageal anastomosis safely and therefore the stomach may not be suitable as a pedicled conduit. Last, ischemia and necrosis of the gastric conduit following esophagectomy will often not be salvageable using muscle flaps and may require resection of the conduit. In all

these cases alternative methods of reestablishing intestinal continuity is required if the patient is to be spared the debilitating fate of a permanent end-esophagostomy. Traditionally, long-segment pedicled colon interposition has been used for this purpose. The colon however has several limitations including a variable blood supply, size mismatch with the esophagus, frequent presence of intrinsic pathologic conditions, and a tendency to develop redundancy and kinking within the chest, leading to long-term functional problems with dysphagia. Pedicled jejunum has been used for esophageal reconstruction, but because of the relatively short length of its mesentery and lack of longitudinal vascular arcades it is generally unsuitable for reconstruction in the upper chest or neck. Additionally, the curvature of the jejunum secondary to the fan-like foreshortening of its mesentery results in a sigmoidal conduit. Division of the mesentery to the mesenteric border of the jejunum allows the jejunum to unfurl, thus straightening the conduit and adding significant length, but creates a devascularized segment proximally. However, the arterial and venous supply of this segment can be restored using microvascular techniques, anastomosing to vessels in the upper thorax or neck. The result is a supercharged jejunal flap (SJF) that can comfortably reach to the hypopharynx, more closely approximates the size of the native esophagus, retains peristalsis, and limits reflux.

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Operative Technique

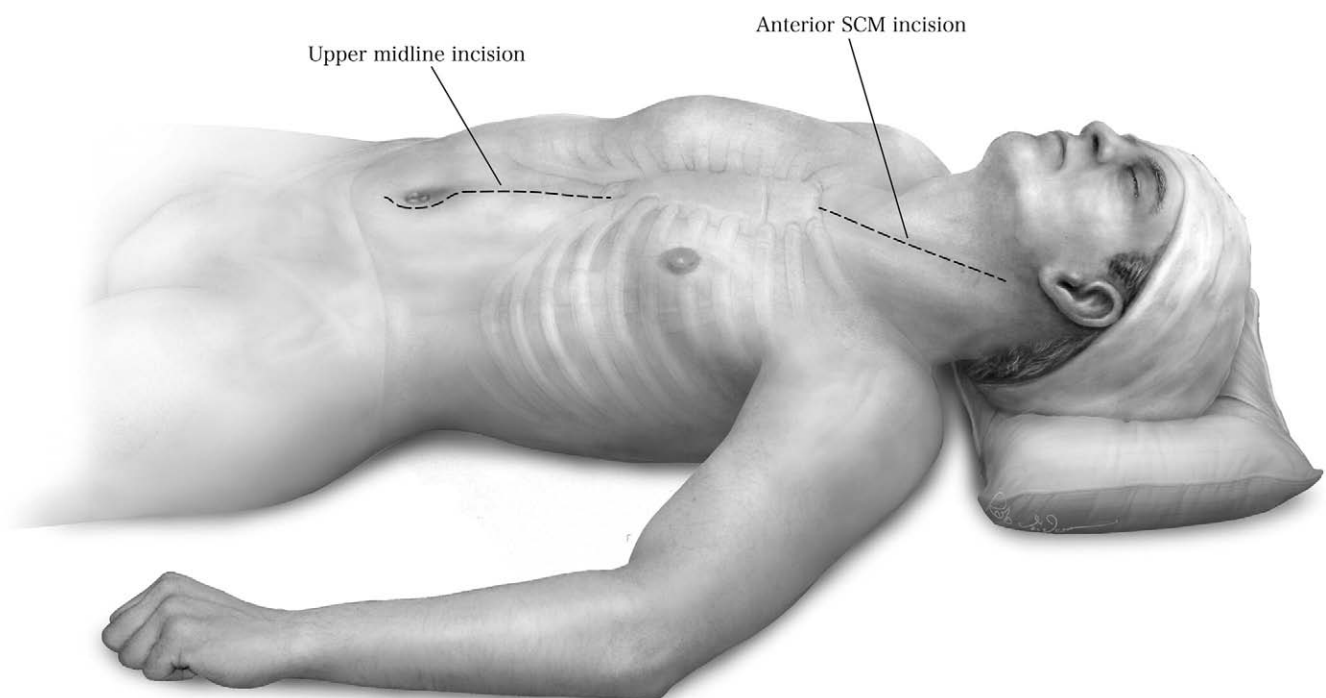


Figure 1 In cases where the native esophagus remains, esophagectomy is first performed usually via a 3-hole or transhiatal technique. Reconstruction is performed with the patient in a supine position with the neck extended slightly toward the right side. An upper midline laparotomy is made and the gastric remnant mobilized, if present. A bilateral subcostal incision can also be used but it is more difficult to gain good exposure of the root of the jejunal mesentery using this incision. For the neck either an incision along the anterior border of the left sternocleidomastoid muscle or a left transverse cervical incision is made. SCM = sternocleidomastoid muscle.

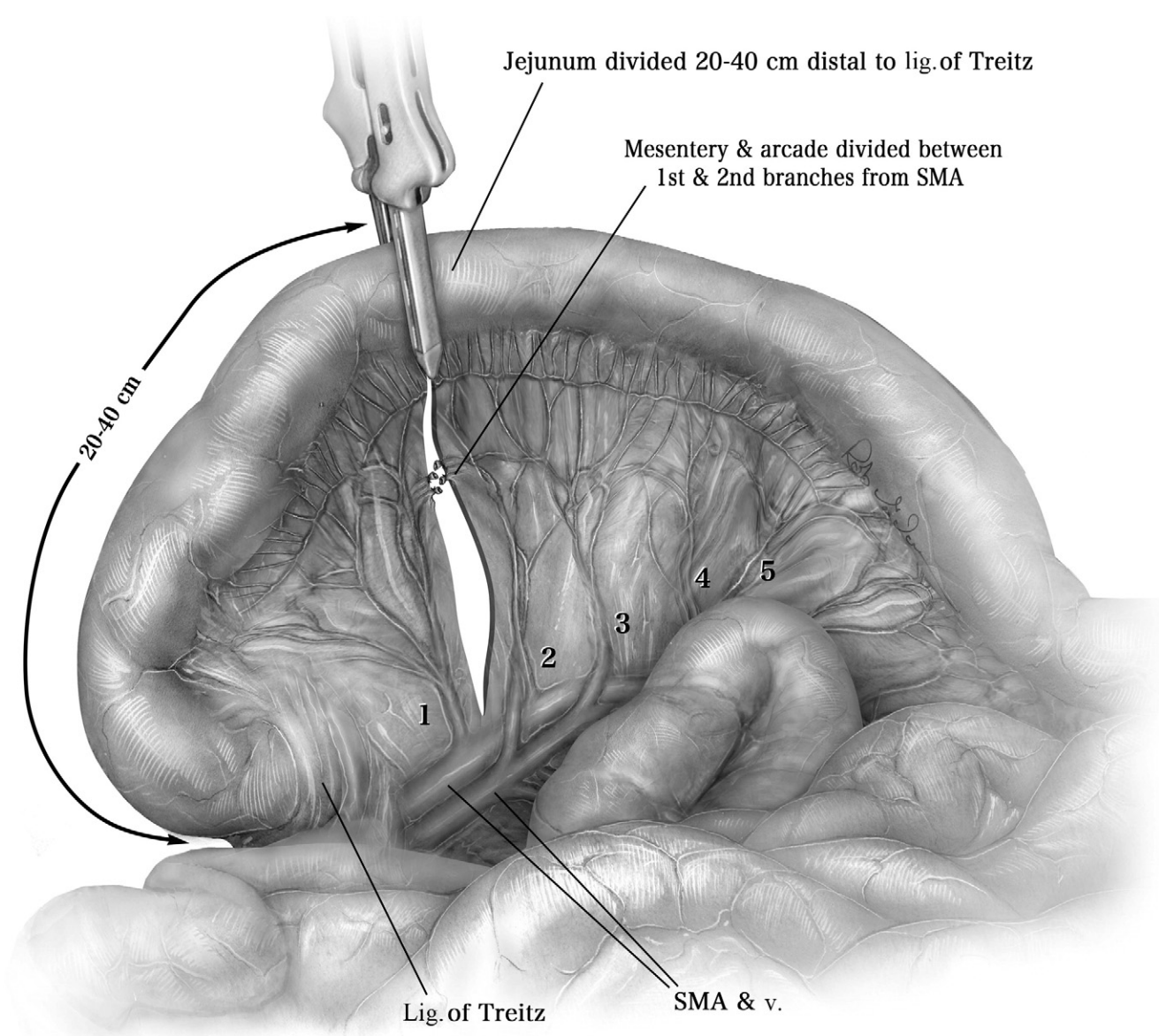


Figure 2 The proximal jejunum and mesentery are divided just distal to the last arborization of the first jejunal mesenteric branch, usually about 20 to 40 cm distal to the ligament of Treitz. The first jejunal branch after the ligament of Treitz is preserved. The 2nd mesenteric branch will be used for microvascular supercharging in the neck, and care must be taken to dissect out sufficient length on this vessel for anastomosis. Lig. = ligament; SMA = superior mesenteric artery; v. = vein.

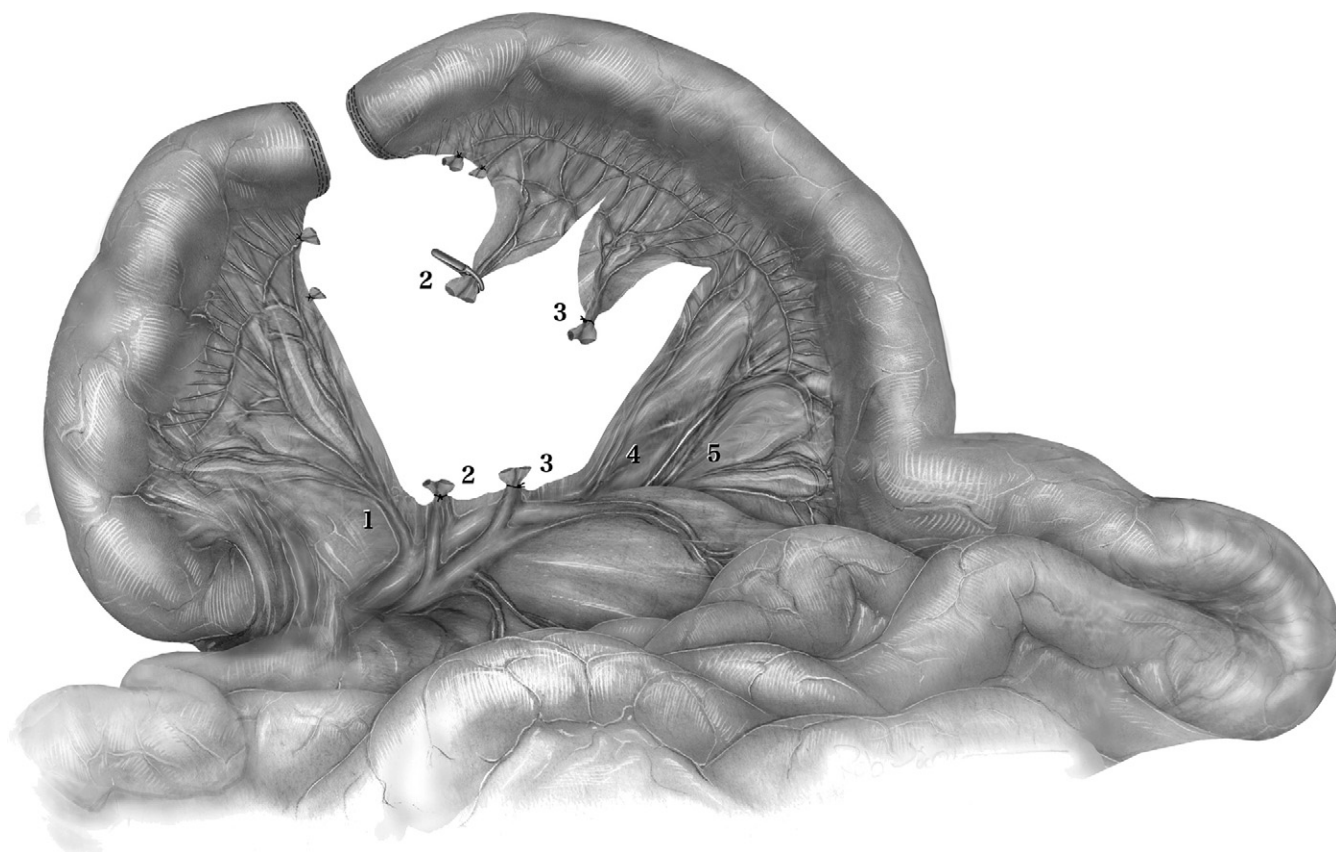


Figure 3 Generally the 3rd arterial and venous branches are ligated, preserving the 4th branch to act as a source for the pedicled graft. Care must be taken exposing and ligating the vessels to avoid bleeding and hematoma, which makes the dissection difficult. Transillumination of the mesentery greatly facilitates accurate dissection. The 2nd jejunal branch will later be used for revascularization in the neck and should be controlled distally with an Acland clamp.

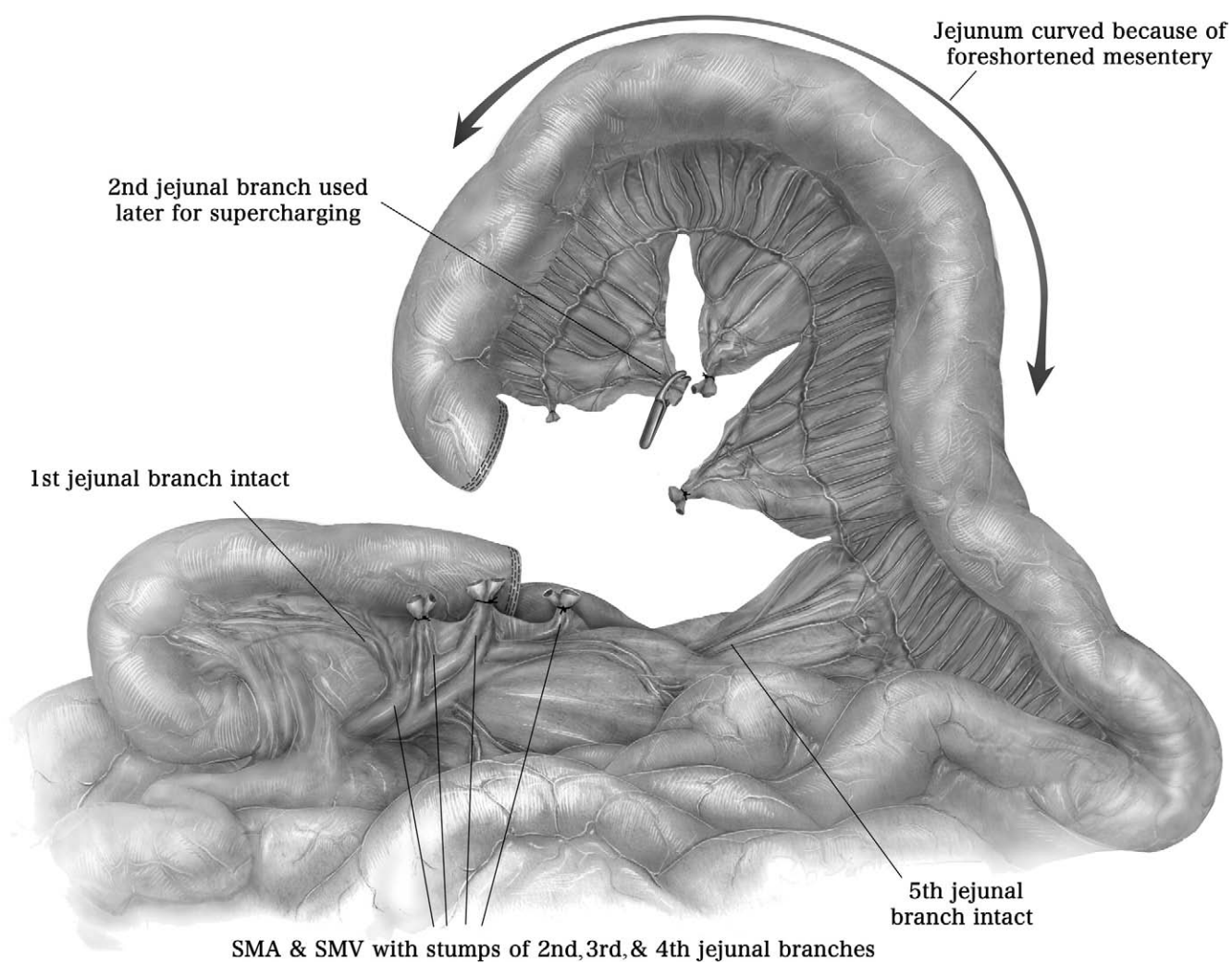


Figure 4 When more length is needed, the 4th arterial and venous branches can be ligated and divided as well, preserving the 5th branch to act as a source for the pedicled graft. The pedicled jejunum is lifted off the SMA. Note the natural curve of the graft, which prevents sufficient length to get up to the neck, in addition to causing tortuosity. SMA = superior mesenteric artery; SMV = superior mesenteric vein.

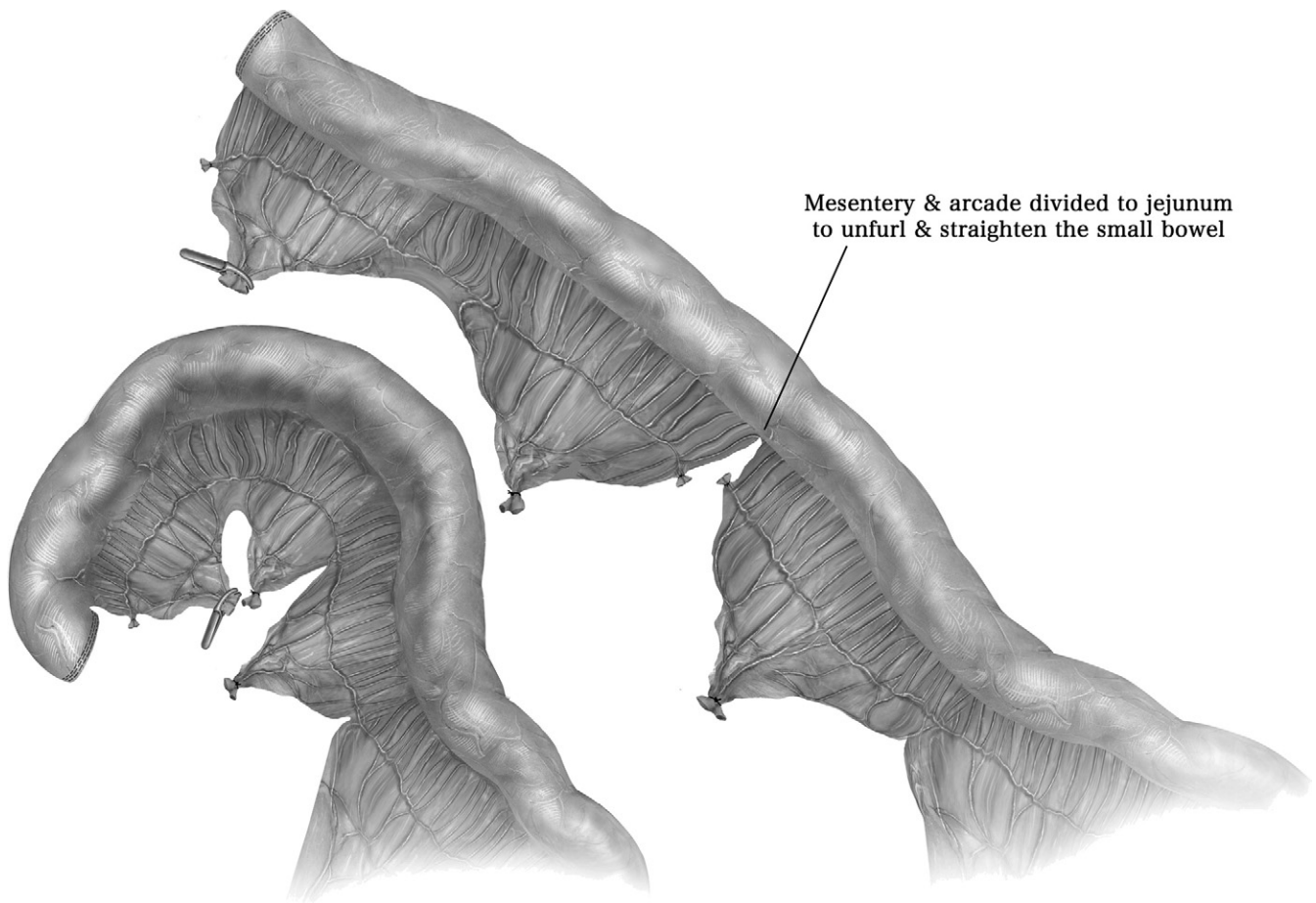


Figure 5 To lengthen and straighten out the graft, the mesentery between the 3rd and 4th vascular branches is divided to the mesenteric surface of the jejunum. However, arcade vessels between the 2nd and 3rd, and between the 4th and 5th branches, should be preserved so that the 5th branch can perfuse the jejunum that is normally supplied by the 4th branch via arcade vessels. The 2nd branch, once supercharged, can perfuse the jejunum that is normally supplied by the 3rd branch via arcade connections. If only the 3rd branch is ligated as shown in Fig. 3, the mesentery between the 2nd and 3rd vessels is divided to the mesenteric border of the jejunum while preserving the arcade vessels between the 3rd and 4th branches. Great care should be taken not to divide or avulse the terminal arborization.

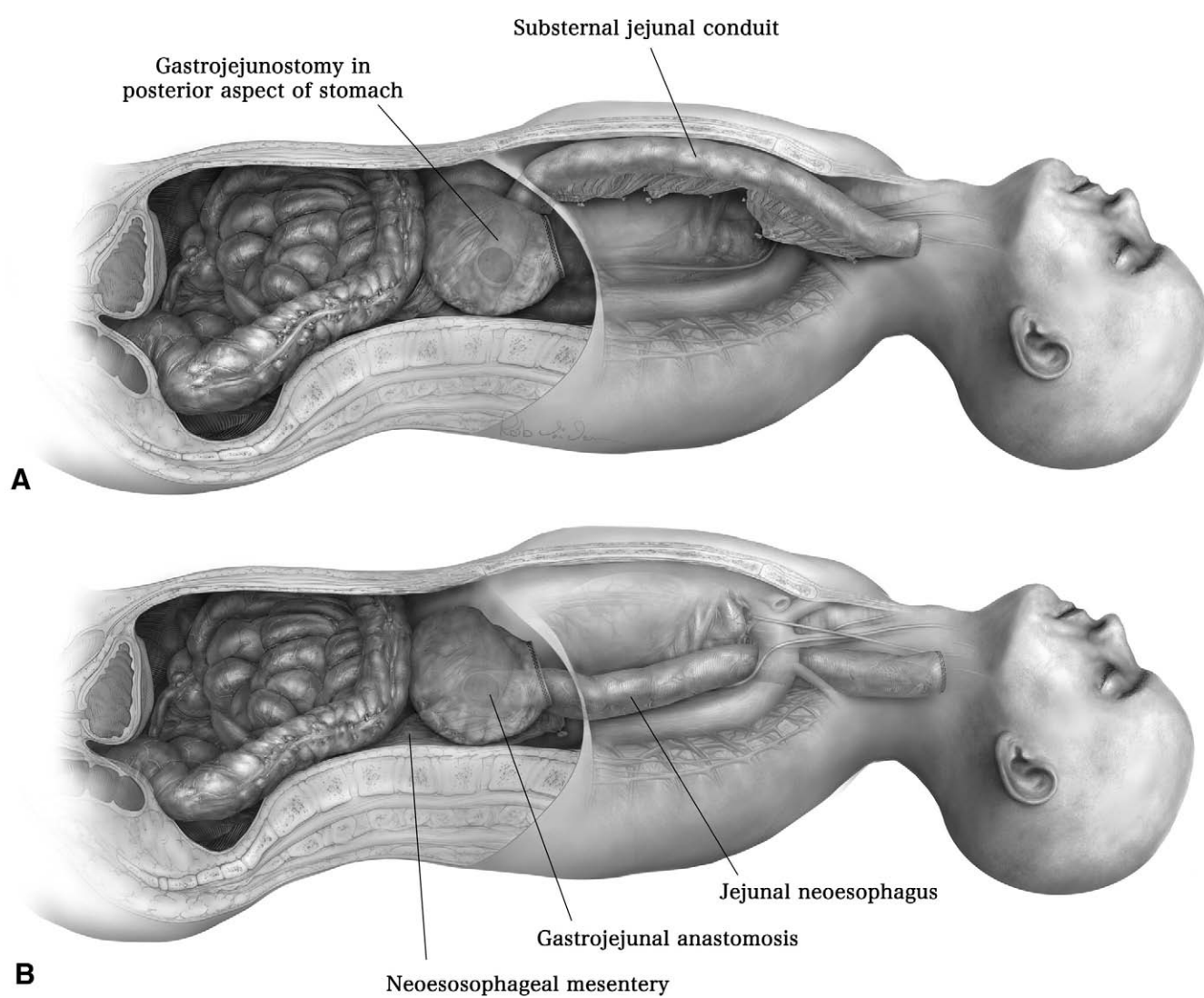


Figure 6 For delayed reconstruction, the retrosternal route (A) is commonly chosen, whereas for immediate reconstruction, the posterior mediastinal (retrocardiac) is usually employed (B).

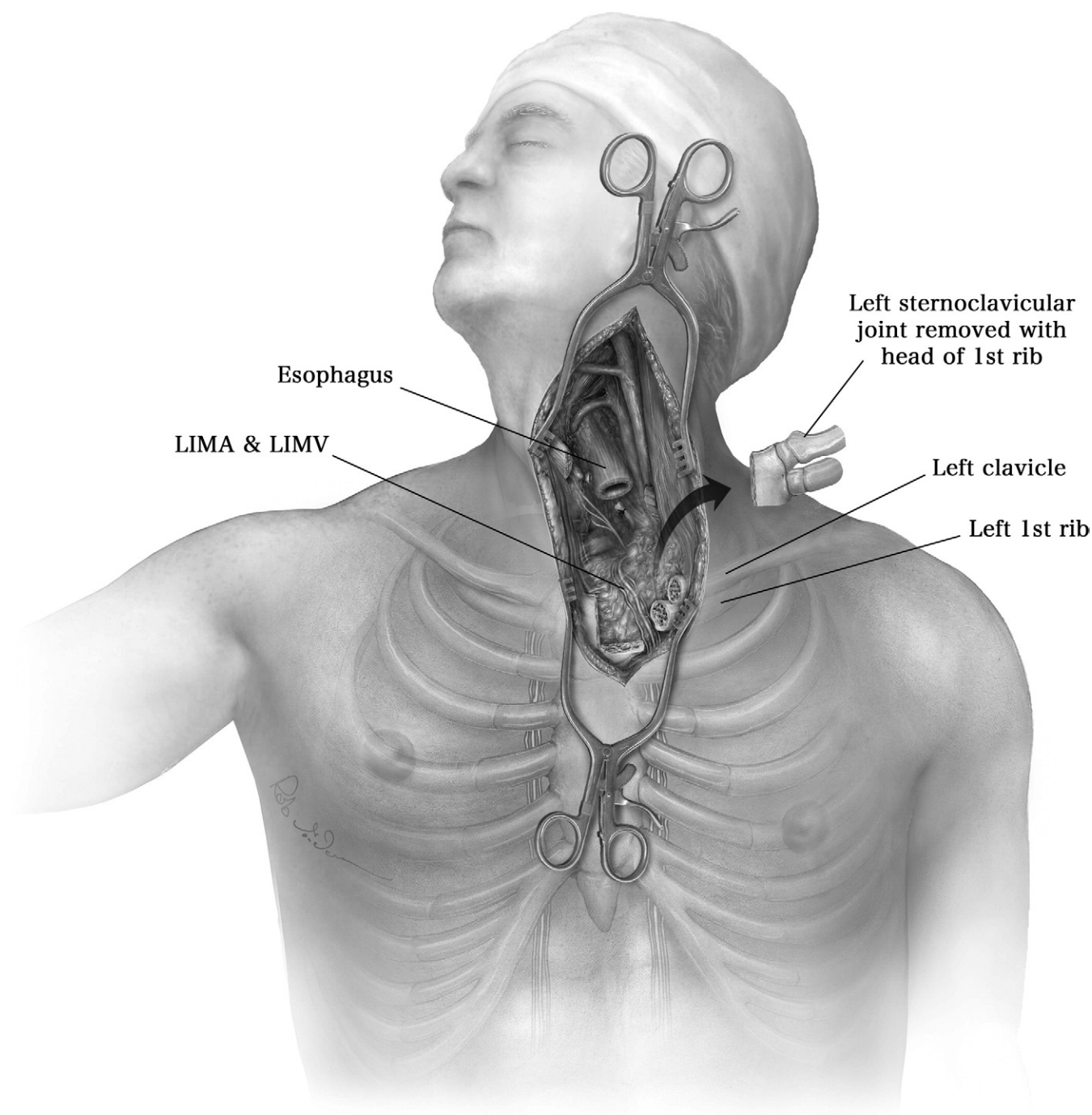


Figure 7 A cervical incision is made. If the conduit is passed retrosternally, then the thoracic inlet needs to be enlarged to prevent kinking or compression of the proximal graft as it exits the thoracic inlet to the neck. This requires resection of the left half of the manubrium, the left clavicular head, and the proximal portion of the 1st rib. This dissection exposes the left internal mammary artery and vein, which can be used for revascularizing the proximal jejunal flap. When the retrocardiac route is chosen, there is no need to remove the manubrium and expose the internal mammary vessels. The transverse cervical vessels are usually available as recipient vessels. The superior thyroid artery can be a second choice with or without a segment of vein graft and the internal jugular vein can be easily reached as the recipient vein without a vein graft. LIMA = left internal mammary artery; LIMV = left internal mammary vein.

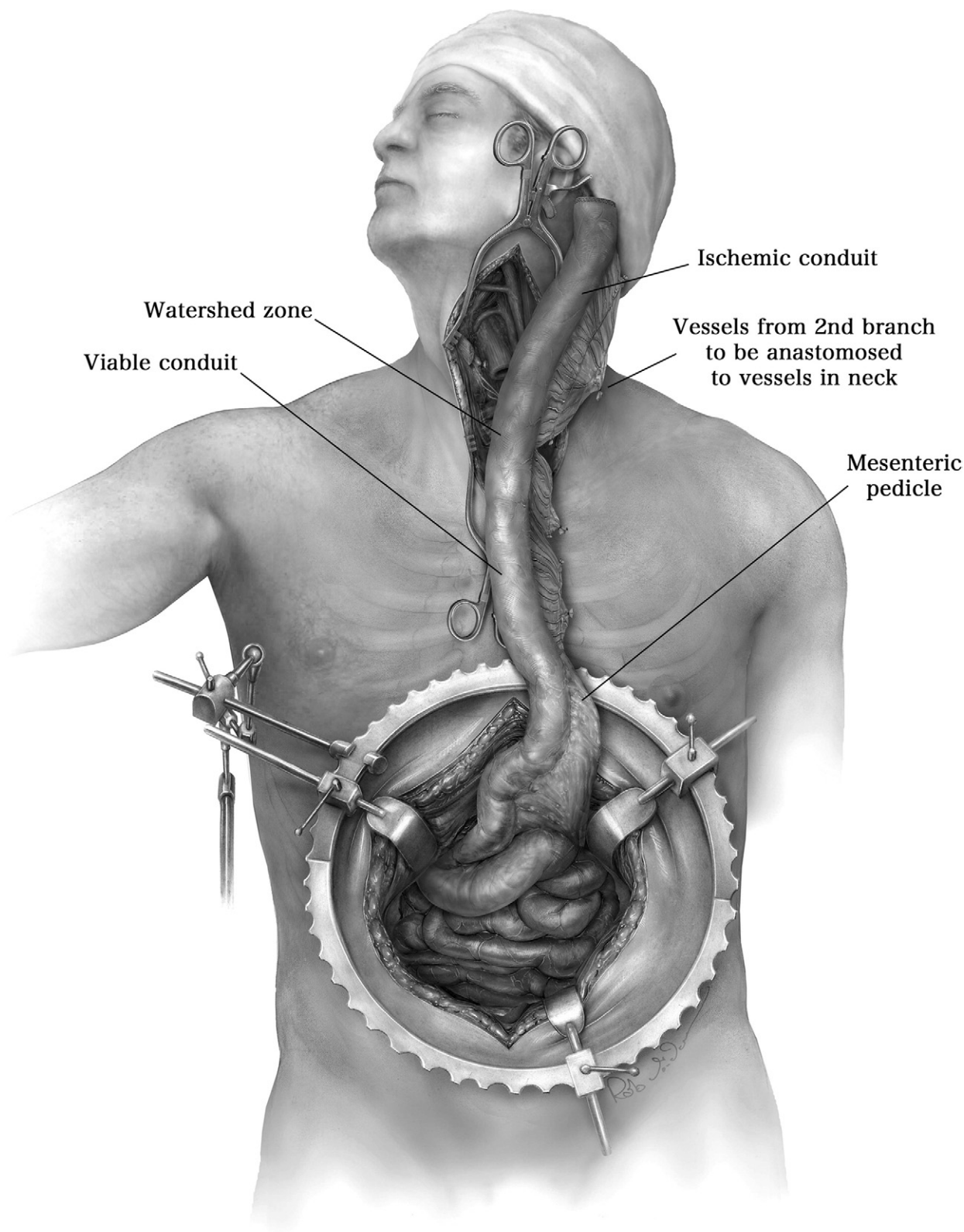


Figure 8 Once harvested and unfurled, the flap is laid out on the anterior chest to assess its length. The SJF can usually reach as far as the hypopharynx without difficulty. The top third will be slightly dusky at this stage. The flap is then passed through the chest in a sterile plastic bag (such as an ultrasound bag) and the proximal end of the flap is delivered into the neck. Care must be exercised to ensure that the conduit does not twist and that excessive traction is not used, as injury to the delicate pedicled mesenteric vessels can cause flap failure. If a nasogastric tube is to be used, then it is preferable to pass a tube retrograde through the SJF flap before passage of the flap through the chest. Once the flap is in the neck, the tip of the tube can be sutured to the end of a nasogastric tube that has been passed antegrade into the cervical esophagus through the nose. The retrograde placed tube can then guide the antegrade tube safely through the conduit. Otherwise, it is virtually impossible to pass a nasogastric tube through the SJF flap in an antegrade fashion without risking injury to the intrathoracic position of the jejunum. Our recent experience suggests that placement of such a nasogastric tube may be unnecessary. A nasogastric tube can be simply placed in the proximal segment of the jejunum immediately below the jejunoesophageal anastomosis under direct vision and it is possible that no tube at all may be required.

End-to-end anastomosis of 2nd branch jejunal vessels with LIMA & LIMV



Figure 9 Once in the neck, the 2nd branch artery and vein are anastomosed to the recipient vessels by the plastic surgical team using the operating microscope. However, the anastomoses can be performed with loupe magnification ($\times 4$ or above) in experienced hands. Either the left internal mammary artery and vein or the transverse cervical vessels can be used as recipient vessels without the need for a vein graft. Occasionally a venous interposition graft from the saphenous vein may be needed if the recipient artery is higher up in the neck, such as the superior thyroid artery or higher. Typically a 9-0 nylon suture is used for the arterial anastomosis in an interrupted fashion. The venous anastomosis is commonly completed using a vein coupler. Heparin, dextran, aspirin, or other anticoagulants are not routinely given during or after microsurgery at M.D. Anderson Cancer Center. Local use of heparin irrigation and papaverine in the surgical field, however, is commonly practiced. Intraoperatively, hypotension and the use of vasopressors should be avoided if possible to prevent vessel spasm. This requires effective communication with the anesthesia team. If prolonged hemodynamic instability occurs, reconstruction should be aborted and delayed until the patient is stable. LIMA = left internal mammary artery; LIMV = left internal mammary vein.

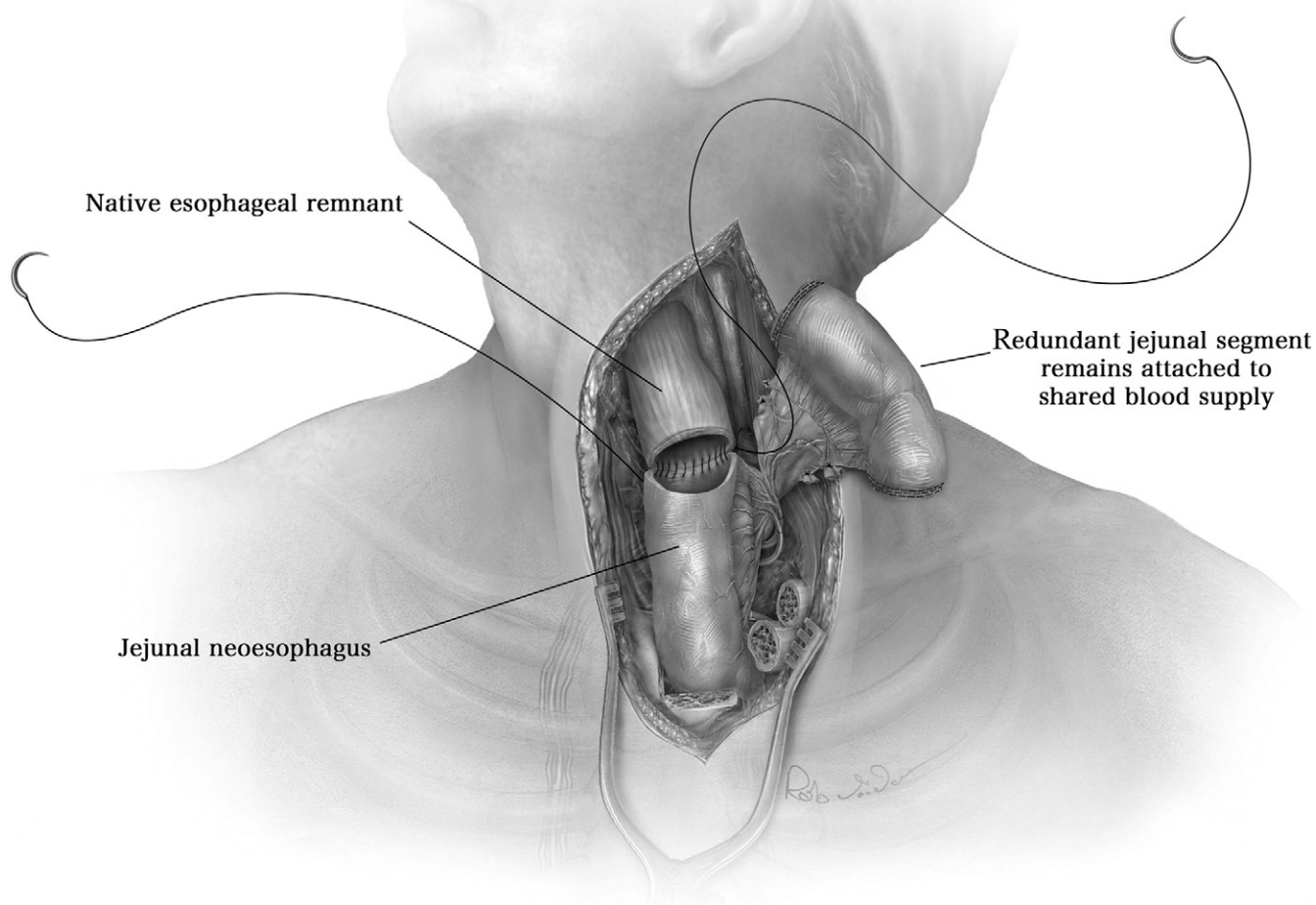


Figure 10 The jejunum is divided at an appropriate level to anastomose with the esophagus. This can be a hand-sewn or stapled anastomosis. A small segment of redundant jejunum based on 1 or 2 terminal branch vessels is used as a monitor flap, which is exteriorized through the neck incision. Because it shares the blood supply with the supercharged portion of the flap, it serves to monitor the vascular perfusion of the proximal jejunum. This segment is removed at the bedside after 7 to 10 days by simply tying down the preplaced ligatures and dividing the mesentery.

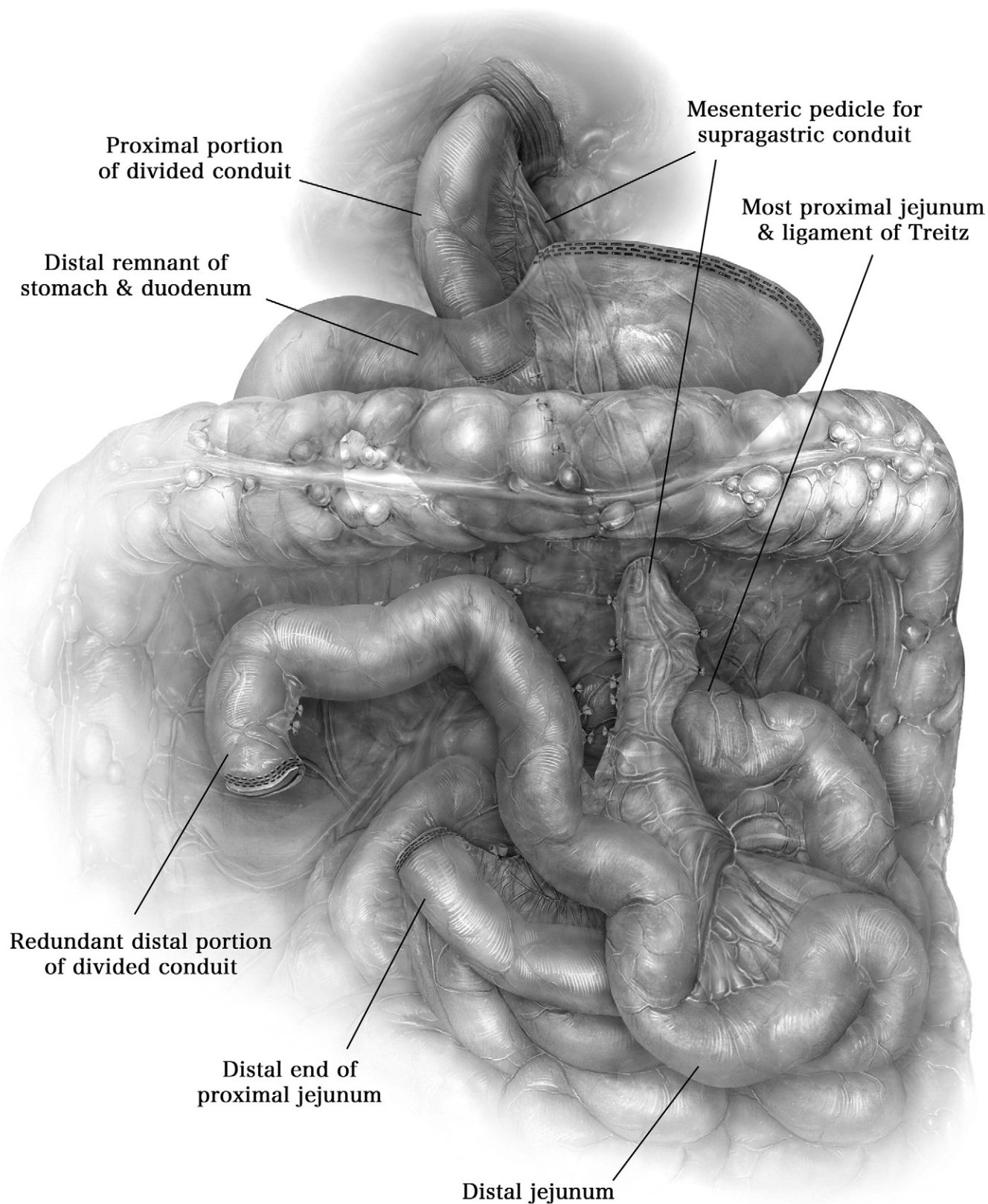


Figure 11 The conduit is usually passed into the chest through the mesocolon and behind the stomach. The jejunum is divided at a place that will comfortably reach to the posterior border of the gastric remnant (if present). There is redundant jejunum behind the colon and stomach, which is resected at the mesenteric border by meticulously ligating the small jejunal branches. Great care must be taken to avoid creating a hematoma in the mesentery as this may compromise vascular supply to the SJF. If there is no gastric remnant, then this portion of jejunum is not removed and a Roux limb is simply used.

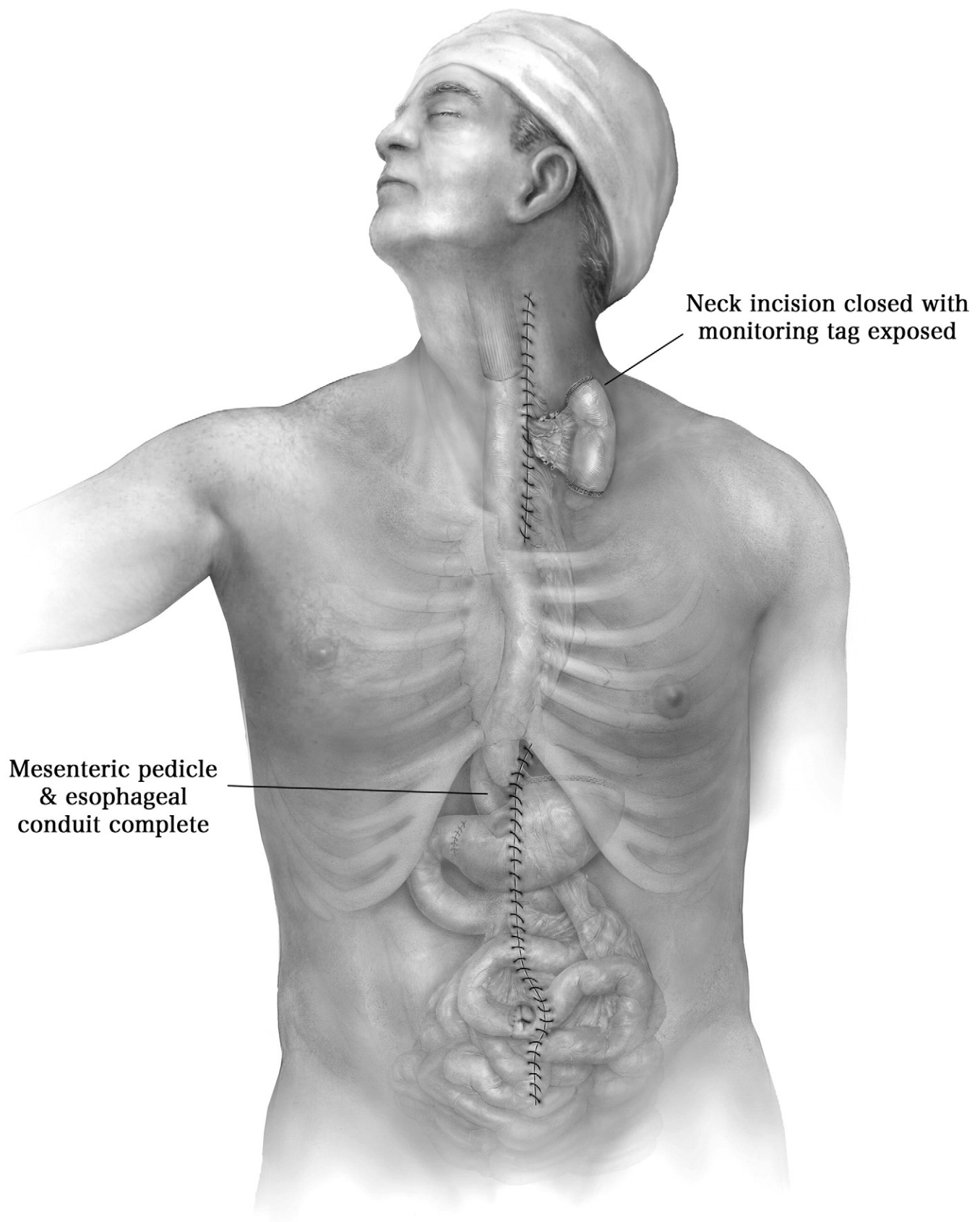


Figure 13 The completed supercharged jejunal flap showing the exteriorized monitor segment, which resides on the skin of the anterior chest. This will later be removed at the bedside after 7 to 10 days. In uncomplicated cases, a modified barium swallow is usually performed 2 weeks postoperatively before initiating an oral diet. If there is a leak, oral intake is withheld for another 2 weeks (or until a fistula heals) and a swallowing study is repeated. Most subclinical leaks resolve within 2 weeks.

Technical Tips

It is most expeditious to have 2 surgical teams operating in tandem. The thoracic surgical team exposes the abdomen and viscera and performs esophagectomy, if needed, while the plastic surgery team performs the neck incision and isolation of the recipient vessels in the neck. The teams then switch places. Harvesting of the jejunal segment is usually performed by the plastic surgical team and transillumination of the mesentery is critical for defining the vascular anatomy. Great care should be exercised when handling the pedicled section of the flap, particularly when delivering the conduit through the chest into the neck. Even slight excess tension may cause avulsion of the arcade vessels, causing devascularization of the mid portion of the jejunal flap. If that happens, the ligated artery or vein of that segment can be trimmed and anastomosed to an artery or vein in the abdomen, such as the gastroepiploic vessels, a branch of the mesocolic vessels, etc. A saphenous vein graft may be needed. As mentioned above, passage of a nasogastric tube can be problematic unless it is first passed retrograde before placement of the conduit into the chest. We have had 2 mid-conduit perforations believed to be due to pressure of the tip of the nasogastric tube at the vascular watershed zone at the mid portion of the conduit. We now avoid using nasogastric tubes in these patients.

Results

The first report of SJF flap for esophageal reconstruction was by Longmire in 1947, who used it in a patient with a cicatricial obstruction following lye ingestion.¹ Others have since

reported use of the technique and references are included in the bibliography.²⁻⁴ In 2005 we published our initial experience at the University of Texas M.D. Anderson Cancer Center.^{5,6} Over a 4-year period, 26 patients underwent esophageal reconstruction with a SJF flap and reconstruction was successful in 24 (92%). There were 2 flap failures: 1 due to avulsion of the mesenteric artery during transfer of the flap through the chest, presumably the result of traction injury; the other flap loss occurred in a patient who developed abdominal compartment syndrome due to multisystem organ failure following a prolonged reconstruction. Cervical anastomotic leaks occurred in 19%; however, all resolved with neck drainage and local wound care. There were no perioperative deaths. At an average follow-up of 32 months, 95% of evaluable patients were tolerating oral intake and had no reflux symptoms. Dumping symptoms were present in only 19%.

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